

## CLAIMS

1. A haptic feedback touch control for inputting signals to a computer and for outputting forces to a user of the touch control, the touch control comprising:

5       a touch input device including an approximately planar touch surface operative to input a position signal to a processor of said computer based on a location on said touch surface which said user contacts, said position signal representing a location in two dimensions, wherein said computer positions a cursor in a graphical environment displayed on a display device based at least in part on said position signal; and

10       at least one actuator coupled to said touch input device, said actuator outputting a force on said touch input device to provide a haptic sensation to said user contacting said touch surface, wherein said actuator outputs said force based on force information output by said processor, said actuator outputting a force directly on said touch input device.

15       2. A haptic feedback touch control as recited in claim 1 wherein said touch input device is a touchpad, said touchpad being separate from a display screen of said computer.

3. A haptic feedback touch control as recited in claim 1 wherein said touch input device is included in a display screen of said computer as a touch screen.

20       4. A haptic feedback touch control as recited in claim 1 wherein said touch input device is integrated in a housing of said computer.

5. A haptic feedback touch control as recited in claim 4 wherein said computer is a portable computer.

6. A haptic feedback touch control as recited in claim 1 wherein said touch input device is provided in a housing that is separate from said computer.

25       7. A haptic feedback touch control as recited in claim 1 wherein said user contacts said touch surface with a finger of said user.

8. A haptic feedback touch control as recited in claim 1 wherein said user contacts said touch surface with a physical object held by said user.

9. A haptic feedback touch control as recited in claim 8 wherein said physical object is a stylus.

10. A haptic feedback touch control as recited in claim 1 wherein said touch input device is integrated in a housing of a handheld device operated by at least one hand of a user.

5        11. A haptic feedback touch control as recited in claim 10 wherein said handheld device is a remote control device for controlling functions of an electronic device or appliance.

12. A haptic feedback touch control as recited in claim 1 wherein said at least one actuator is a first actuator, and further comprising at least one additional actuator coupled to said touch input device for outputting a force on said touch input device.

10        13. A haptic feedback touch control as recited in claim 1 wherein said force is a linear force output approximately perpendicularly to a plane of said touch surface of said touch input device.

14. A haptic feedback touch control as recited in claim 13 wherein said actuator is a linear actuator that provides an output force in a linear degree of freedom, and wherein said  
15        actuator is rigidly coupled to said touchpad and rigidly coupled to a grounded housing.

15. A haptic feedback touch control as recited in claim 13 wherein said actuator is a rotary actuator that provides an output force in a rotary degree of freedom, said output force being converted to said linear force on said touch input device.

16. A haptic feedback touch control as recited in claim 1 wherein said actuator includes a  
20        piezo-electric actuator.

17. A haptic feedback touch control as recited in claim 1 wherein said actuator includes a voice coil actuator.

18. A haptic feedback touch control as recited in claim 1 wherein said actuator includes a pager motor.

25        19. A haptic feedback touch control as recited in claim 1 wherein said actuator includes a solenoid.

20. A haptic feedback touch control as recited in claim 1 further comprising a touch device microprocessor separate from said processor and providing control signals to control said actuator.

21. A haptic feedback touch control as recited in claim 1 wherein said actuator outputs a vibration or a pulse tactile sensation on said touch input device.

22. A haptic feedback touch control as recited in claim 1 wherein said touch input device includes a plurality of different regions, wherein at least one of said regions provides said position signal and at least one other region provides a signal that is used by said computer to control a different function.

23. A haptic feedback touch control as recited in claim 22 wherein said different function includes a rate control function of a value.

24. A haptic feedback touch control as recited in claim 22 wherein said different function includes a button press.

25. A haptic feedback touch control as recited in claim 22 wherein at least one of said regions is associated with a different haptic sensation output on said touch input device than another one of said regions.

26. A haptic feedback touch control as recited in claim 22 wherein a haptic sensation is output when said user moves a contacting object from one of said regions to another one of said regions.

27. A haptic feedback touch control as recited in claim 1 further comprising a sensor for detecting motion or position of said touch input device approximately perpendicularly to said touch surface, wherein an input signal based on said detected motion or position is sent to said computer.

28. A haptic feedback touch control as recited in claim 1 wherein said processor outputs said force information to provide said haptic sensation in accordance with an interaction of said cursor with a graphical object in said graphical environment.

29. A haptic feedback touch control as recited in claim 1 wherein a menu is displayed in said graphical environment, wherein when said cursor is moved between menu elements in said menu, a pulse is output on said touch input device, said pulse causing said touch input device to move along said z-axis and conveying said pulse to said user contacting said touch surface.

30. A haptic feedback touch control as recited in claim 1 wherein an icon is displayed in said graphical environment, wherein when said cursor is moved over said icon, a pulse is output on said touch input device, said pulse causing said touch input device to move along said z-axis and conveying said pulse to said user contacting said touch surface.

31. A haptic feedback touch control as recited in claim 1 wherein a menu is displayed in said graphical environment, wherein when said cursor is moved between menu elements in said menu, a pulse is output on said touch input device, said pulse causing said touch input device to move along said z-axis and conveying said pulse to said user contacting said touch surface.

5        32. A haptic feedback touch control as recited in claim 1 wherein a web page is displayed in said graphical environment and a hyperlink is displayed on said web page, wherein when said cursor is moved over said hyperlink, a pulse is output on said touch input device, said pulse causing said touch input device to move along said z-axis and conveying said pulse to said user contacting said touch surface.

10        33. A haptic feedback touch control for inputting signals to a computer and for outputting forces to a user of the touch control, the touch control comprising:

15        a touch input device including an approximately planar touch surface operative to input a position signal to a processor of said computer based on a location on said touch surface which said user contacts, said position signal representing a location in two dimensions, wherein said computer positions a cursor in a graphical environment displayed on a display device based at least in part on said position signal; and

20        an actuator coupled to said touch input device, said actuator coupled to an inertial mass, wherein said actuator outputs an inertial force approximately along an axis perpendicular to said planar touch surface, wherein said inertial force is transmitted through said touch input device to said user contacting said touch surface.

34. A haptic feedback touch control as recited in claim 33 wherein said actuator is a linear actuator that moves said inertial mass bi-directionally along a linear axis that is substantially perpendicular to said planar touch surface.

25        35. A haptic feedback touch control as recited in claim 33 wherein said touch input device is a touchpad separate from a display screen of said computer.

36. A haptic feedback touch control as recited in claim 33 wherein said touch input device is included in a display device of said computer to provide a touch screen.

37. A method for providing haptic feedback to a touch input device that provides input to a computer device, said computer device implementing a graphical environment, the method comprising:

5 providing said touch input device that is contacted by a user, said touch input device including at least one sensor for determining a location of said contact on a planar surface of said touch input device by said user and providing said computer device with a position signal indicating said location, wherein said computer device positions a cursor in said graphical environment based at least in part on said position signal; and

10 providing an actuator coupled to said touch input device, said actuator receiving control signals derived from force information output by said computer device, wherein said force information causes said actuator to output a force on said touch input device, said force being correlated with an interaction occurring in said graphical environment between said cursor and a different graphical object.

15 38. A method as recited in claim 37 wherein said force output on said touch input device is a linear force approximately perpendicular to said surface of said touch input device.

39. A method as recited in claim 37 wherein a touch device microprocessor, separate from a host processor of said computer device, receives said force information from said host processor and causes said control signals to be sent to said actuator.

20 40. A method as recited in claim 37 wherein said interaction occurring in said graphical environment includes a collision between said cursor and said different graphical object.

41. A method as recited in claim 37 wherein said interaction occurring in said graphical environment includes a selection of said different graphical object by said cursor, wherein said different graphical object is one of an icon, a window, and a menu item.

25 42. A method as recited in claim 37 wherein said touch input device is moveable along an axis approximately perpendicular to said planar surface of said touch input device, wherein said movement along said axis is sensed and information representative of said movement is sent to said computer device.

30 43. A method as recited in claim 37 wherein said computer device is portable, said touch input device is integrated in a housing of said computer device, and said actuator is a piezo-electric actuator.